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**FACSIMILE TRANSMITTAL SHEET**

TO: EXAMINER ULLAH

FROM: SUSAN MORSE

COMPANY: US PATENT & TRADEMARK OFFICE  
Group Art Unit 2874

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☒ URGENT ☐ FOR REVIEW ☒ PLEASE COMMENT ☒ PLEASE REPLY ☐ PLEASE RECYCLE

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Attached please find the search report, the International Preliminary Examination Report with a copy of the pending claims and the Japanese reference from the PCT parent application. The other reference on the search report is a US patent. Please let me know if you need anything else. Thank you.

Susan Morse

LEE & STERBA, P.C.

## INTERNATIONAL SEARCH REPORT

Int. nat. Application No

PCT/US 01/20033

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 G02B3/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

PAJ, EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 017, no: 275 (M-1418), 27 May 1993 (1993-05-27) -& JP 05 008441 A (KYOCERA CORP), 19 January 1993 (1993-01-19) abstract paragraphs '0001!', '0002!', '0008!', '0009!', '0015!; figures 5-8	1,2,4-6, 9,13-17, 19-22, 24-27
X	US 5 444 572 A (SHOUGH DEAN M ET AL) 22 August 1995 (1995-08-22) column 5, line 1 - column 6, line 2 column 3, line 40 - line 45; figures 1,8-11	1,2,5



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

## \* Special categories of cited documents:

\*A\* document defining the general state of the art which is not considered to be of particular relevance

\*E\* earlier document but published on or after the international filing date

\*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

\*O\* document referring to an oral disclosure, use, exhibition or other means

\*P\* document published prior to the international filing date but later than the priority date claimed

\*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

\*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

\*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

\*Z\* document member of the same patent family

Date of the actual completion of the international search

8 October 2002

Date of mailing of the international search report

17/10/2002

Name and mailing address of the ISA

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Authorized officer

Scheu, M

## PATENT COOPERATION TREATY

From the  
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

Morse, Susan S.  
DIGITAL OPTICS CORPORATION  
9815 David Taylor Drive  
Charlotte, NC 28262  
ETATS-UNIS D'AMERIQUE

RECEIVED

JUN 21 2003

PCT

NOTIFICATION OF TRANSMITTAL OF  
THE INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT

(PCT Rule 71.1)

Date of mailing  
(day/month/year) 17.06.2003

Applicant's or agent's file reference  
DOC.071PCT

## IMPORTANT NOTIFICATION

International application No.  
PCT/US01/20033

International filing date (day/month/year)  
22/06/2001

Priority date (day/month/year)  
09/02/2001

Applicant

DIGITAL OPTICS CORPORATION et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.
4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

For the purpose of deciding whether the claimed invention is patentable or not, the elected Offices may apply criteria additional to or different from the criteria on which the international preliminary examination report is based (see Articles 27(5), 33(5)). Additional criteria may include e.g. exemptions from patentability and the requirements of enabling disclosure and of clarity and support of claims.

Name and mailing address of the IPEA/

Authorized officer



## PATENT COOPERATION TREATY

## PCT

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT


(PCT Article 36 and Rule 70)

Applicant's or agent's file reference DOC.071PCT	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/US01/20033	International filing date (day/month/year) 22/06/2001	Priority date (day/month/year) 09/02/2001
International Patent Classification (IPC) or national classification and IPC G02B3/00		
Applicant DIGITAL OPTICS CORPORATION et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 6 sheets, including this cover sheet.
- ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).
- These annexes consist of a total of 5 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 04/09/2002	Date of completion of this report 17.06.2003
Name and mailing address of the International preliminary examining authority: European Patent Office - P.B. 5818 Patentlaan 2	Authorized officer 

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**International application No. **PCT/US01/20033****I. Basis of the report**

1. With regard to the elements of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):
- Description, pages:

1-9 as originally filed

**Claims, No.:**

1-27 as received on 18/12/2002 with letter of 17/12/2002

**Drawings, sheets:**

1/4-4/4 as originally filed

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**International application No. **PCT/US01/20033**☐ the drawings. sheets:

5. ☒ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*  
**see separate sheet**

6. Additional observations, if necessary:

**III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability**

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

☐ the entire international application.

☒ claims Nos. 1-11.

because:

☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (*specify*):

☒ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. 1-11 are so unclear that no meaningful opinion could be formed (*specify*):  
**see separate sheet**

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

☐ no international search report has been established for the said claims Nos. .

2. A meaningful international preliminary examination cannot be carried out due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

☐ the written form has not been furnished or does not comply with the standard.

☐ the computer readable form has not been furnished or does not comply with the standard.

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)

Yes: Claims 12-27

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**International application No. **PCT/US01/20033**

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	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	12-27
Industrial applicability (IA)	Yes:	Claims	12-27
	No:	Claims	

2. Citations and explanations  
see separate sheet

**INTERNATIONAL PRELIMINARY**

International application No. PCT/US01/20033

**EXAMINATION REPORT - SEPARATE SHEET**

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**Re Item III****Non-establishment of opinion with regard to novelty, inventive step and industrial application**

1. The amendments filed with telefax of 18-12-2002 introduce subject-matter which extends beyond the content of the application as filed, contrary to Article 34 (2) (b) PCT. The amendments concerned are claims 2 and 3 (claim dependency on claim 7 not originally disclosed) and claims 4-6 (originally dependent only on originally filed claim 1; now dependent on new claim 1, which is the combination of originally filed claims 1 and 3).

Independent claims 1, 7 and 10 lack do not meet the requirements of Article 6 PCT regarding conciseness for the following reasons:

The feature "when said refractive surface deviates from a desired optical performance.....substantially a same desired optical performance" is unclear as each skilled person can define a different desired optical performance. The repeated appearance of this unclear feature in the claims creates a confusion about the scope of the claim. Furthermore it is not clear if the "desired optical performance" relates to the refractive surface alone or to the combination of refractive surface and corresponding compensation surface. Also the feature "desired" focal length is unclear for the same reasons as mentioned before.

Due to the lack of clarity of claims 1, 7 and 10 it has been assumed that these independent features are related to similar subject matter and, therefore lack conciseness as the application contains an unnecessary number of independent claims.

It has to be noted that this lack of clarity restrained the PCT Examining Authority to examine the compliance of claims 1, 7 and 10 with the requirements of unity of invention (Rule 13(1),(2) PCT).



**INTERNATIONAL PRELIMINARY** International application No. PCT/US01/20033  
**EXAMINATION REPORT - SEPARATE SHEET**

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**Re Item V**

**Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

Claim 1 is not inventive, contrary to the requirement of Art 33 (3) PCT for the following reasons:

The feature separating the plurality of pairs into a "desired number" of micro optical components encompasses also the "desired number" one or even zero, hence it encompasses no separation at all.

JP05008441 (=D1) , which is considered to represent the most relevant state of the art, discloses (cf. figures 5-7, paragraphs [0008-0009]) a method of forming micro-optical components having a "desired" optical performance (the focal length) in which refractive lenses (2) are created, compensation surfaces (4) are provided, measured optical performance is compared with a desired optical performance to create refractive lens (2)- compensation surface (4) pairs, wherein each pair has its desired optical functioning.

Hence the subject matter of claim 12 differs from D1 in that the compensation in claim 12 is achieved by forming a compensation profile on a compensation surface, whereas in D1 the thickness of a synthetic resin with a known index of refraction is chosen to compensate for variations in the focal length of the lens. It is however generally known to the person skilled in the art that these features are equivalent and can be interchanged where circumstances make it desirable. Hence claim 12 lacks an inventive step.

Dependent claims 13-27 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of inventive step as they are either disclosed in D1 or are within customary practice to the skilled person.

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International Serial No.: PCT/US01/20033

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1. An array of micro-optical components comprising;  
at least two micro-optical components, each micro-optical component comprising  
a refractive surface, and  
a corresponding compensation surface for said refractive surface, said  
corresponding compensation surface including a corresponding compensation  
feature when said refractive surface deviates from a desired optical  
performance, said micro-optical component providing the desired optical  
performance,  
at least two refractive surfaces of the array of micro-optical components being  
formed to have substantially a same desired optical performance, the array of micro-  
optical components including at least one corresponding compensation feature, at least  
two compensation surfaces of the array of micro-optical components being different  
from one another, wherein at least two combinations of refractive surfaces and  
corresponding compensation surfaces operate at different focal lengths.
2. The array of claim 7, wherein all combinations of refractive surfaces and  
corresponding compensation surface operate at a same focal length.
3. The array of claim 7, wherein at least two combinations of refractive surfaces  
and corresponding compensation surfaces operate at different focal lengths.
4. The array of claim 1, wherein said at least two refractive surfaces and said  
corresponding compensation surfaces are formed on a same substrate.
5. The array of claim 1, wherein said at least two refractive surfaces and said  
corresponding compensation profiles are formed on different substrates of at least two  
substrates bonded together.
6. The array of claim 1, wherein corresponding compensation features correct for  
aberrations in a corresponding refractive surface.

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International Serial No.: PCT/US01/20033

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7. An array of micro-optical components comprising;

at least two micro-optical components, each micro-optical component comprising

5 a refractive surface, and

a corresponding compensation surface for said refractive surface, said corresponding compensation surface including a corresponding compensation feature when said refractive surface deviates from a desired optical performance, said micro-optical component providing the desired optical performance,

10 at least two refractive surfaces of the array of micro-optical components being formed to have substantially a same desired optical performance, the array of micro-optical components including at least one corresponding compensation feature, at least two compensation surfaces of the array of micro-optical components being different  
15 from one another, wherein corresponding compensation features comprise a corresponding separation of the corresponding compensation surface from the refractive surface in accordance with a desired focal length of the combination of the refractive surface and the corresponding compensation surface.

20 8. The array of claim 7, wherein corresponding separations are also formed in accordance with a measured focal length of a corresponding refractive surface.

9. The array of claim 1, wherein a desired focal point of the micro-optical component is on a back surface of a substrate on which said at least two micro-optical  
25 components are formed or on a substrate bonded thereto.

10. An array of micro-optical components comprising;  
at least two micro-optical components, each micro-optical component comprising

30 a refractive surface, and

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a corresponding compensation surface for said refractive surface, said corresponding compensation surface including a corresponding compensation feature when said refractive surface deviates from a desired optical performance, said micro-optical component providing the desired optical performance,

at least two refractive surfaces of the array of micro-optical components being formed to have substantially a same desired optical performance, the array of micro-optical components including at least one corresponding compensation feature, at least two compensation surfaces of the array of micro-optical components being different from one another, wherein corresponding compensation features include a diffractive element.

11. The array of claim 10, wherein the diffractive element corrects for aberrations in a corresponding refractive surface.

12. A method of forming micro-optical components having a desired optical performance comprising:

creating a plurality of refractive surfaces on a substrate;

providing a corresponding plurality of compensation surfaces, one for each refractive surface;

measuring an optical performance of at least one refractive surface of said refractive surfaces;

comparing measured optical performance with a desired optical performance;

forming a compensation profile on a compensation surface when a corresponding refractive surface deviates from its desired optical performance;

creating refractive surface-compensation surface pairs, each pair having its desired optical functioning; and

separating the plurality of pairs into a desired number of micro-optical components, each pair including a refractive surface and a compensation surface.

13. The method of claim 12, wherein said separating creates a plurality of pairs.

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14. The method of claim 12, wherein said separating creates at least one array of pairs.

5 15. The method of claim 12, wherein said forming of compensation features includes forming compensation features on the substrate on which the plurality of refractive surfaces have been formed.

10 16. The method of claim 12, wherein said forming of compensation features includes forming the compensation features on a different substrate than the substrate on which the plurality of refractive surfaces have been formed, the method further comprising bonding the substrate having the compensation features and the substrate having the plurality of refractive surfaces.

15 17. The method of claim 12, wherein said forming of compensation features includes etching the substrate in accordance with a desired focal length of the micro-optical component.

20 18. The method of claim 17, wherein said etching results in different focal lengths for at least two of the micro-optical components.

19. The method of claim 12, wherein said forming of compensation features includes etching the substrate in accordance with a measured focal length of the corresponding refractive surface.

25

20. The method of claim 12, wherein said forming of compensation features includes etching using a single mask to simultaneous create a pattern for all of the compensation features.

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21. The method of claim 12, wherein said forming of compensation features includes etching using a single mask to create a pattern for the compensation features, the single mask being moved to create the pattern for the compensation features.
- 5 22. The method of claim 12, wherein a desired focal point of the micro-optical components is on a back surface of a substrate on which said at least two refractive surfaces are formed or on a substrate bonded thereto.
23. The method of claim 12, wherein said forming of compensation features  
10 includes forming a diffractive element.
24. The method of claim 12, wherein said forming of compensation features includes creating at least two corresponding compensation features for different compensation surfaces that are different from one another.
- 15 25. The method of claim 12, wherein said creating of the plurality of refractive surfaces includes using the same process for all of the refractive surfaces.
26. The method of claim 12, further wherein said measuring of optical performance  
20 includes measuring optical performance for each refractive.
27. The method of claim 12, further wherein said measuring of optical performance includes measuring optical performance for a subset of said plurality of refractive surfaces.

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P. 001

**EUROPEAN PATENT OFFICE****Patent Abstracts of Japan**

PUBLICATION NUMBER : 05008441

PUBLICATION DATE : 19-01-93

APPLICATION DATE : 29-06-91

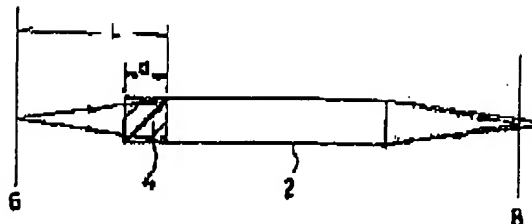
APPLICATION NUMBER : 03185247

APPLICANT : KYOCERA CORP;

INVENTOR : MURANO SHUNJI;

INT.CL. : B41J 2/44 G02B 3/00 G02F 1/1335  
H01L 33/00

TITLE : IMAGING DEVICE



**ABSTRACT :** **PURPOSE:** To prevent the fogging of the surface of the lens array of an imaging device by protecting the surface from ozone generated by discharge in a copier, to also prevent the disturbance of an image by flattening the surfaces of lenses and to correct the irregularity of focus positions at every lenses.

**CONSTITUTION:** A film of a transparent synthetic resin 4 is provided to the surface of a lens array not only to block a lens 2 from nitric acid mist generated from ozone but also to flatten the surface of the lens 2. The thickness of the transparent synthetic resin 4 to be applied is determined based on whether the lens 2 is a long or short focus and the transparent synthetic resin 4 is applied so as to become thick on the side of a light source surface 6 in the case of the long focus and on the side of an image forming surface 8 in the case of the short focus.

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P.002

(18) 日本国特許庁 (J P)

(12) 公開特許公報 (A)

(11) 特許出願公開番号

特開平5-8441

(43) 公開日 平成5年(1993)1月18日

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B 4 1 J 2/44				
G 0 2 B 3/00		A 8106-2K		
G 0 2 F 1/1335		7724-2K		
H 0 1 L 33/00		M 8834-4M		
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(71) 出願人 000000000

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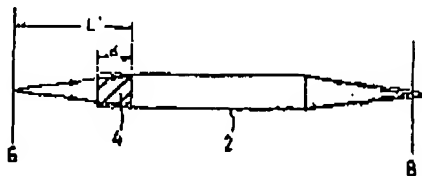
(74) 代理人 井西士 雄入 明 (外1名)

(54) 【発明の名称】 画像装置

(57) 【要約】

【目的】 画像装置のレンズアレイの表面を真空相等の放電で生じるオゾン等から保護し、曇りを防止すると共に、レンズ表面を平坦化し画像の乱れを防止する。更にレンズ毎の焦点位置のばらつきを補正する。

【構成】 レンズアレイの表面に透明合成樹脂の被覆を設け、レンズをオゾン等から生じた雨酸ミストと遮断すると共に、表面を平坦化する。被覆する透明合成樹脂の厚さは、レンズが焦点点か近焦点かで定め、近焦点であれば光源面側を厚く、近焦点で有れば結像面側を厚く被覆する。





(3)

特開平5-8441

【特許請求の範囲】

【請求項1】 同像素子と、該同像素子と光学的に結合したレンズアレイとを組み合わせた同像装置において、前記レンズアレイの少なくとも一部のレンズ表面を、透明合成樹脂で被覆したことを特徴とする、同像装置。

【発明の詳細な説明】

【0001】

【発明の利用分野】 この発明は、LEDプリンタヘッドや液晶シャッタプリンタヘッド、倍率型イメージセンサ等の同像装置に関し、特に用いるレンズアレイの改良に関する。

【0002】

【従来の技術】 LEDアレイや液晶シャッタアレイと、セルフフォーカシングレンズアレイ等のレンズアレイを組み合わせた、プリンタヘッドは周知である。またセルフフォーカシングレンズアレイ等のレンズアレイと、光電素子アレイ等とを組み合わせた倍率型イメージセンサも周知である。これらの同像装置では、レンズアレイの性能が重要である。

【0003】 しかしながらレンズアレイの第1の問題として、焦点のばらつきがある。レンズアレイの焦点のばらつきは、レンズ内での屈折率分布のばらつき、個々のレンズの長さのばらつき、レンズのピッチ精度が低下したりレンズが傾いたりする等のレンズの製造精度の低下により生じる。レンズアレイの第2の問題として、レンズ表面が紫外線等の露光ドラムでの放電部で生じるオゾン等で曇る事がある。オゾンによる曇りは、コロナ放電で生じたオゾンが空気と反応して酸素酸化物が生成し、生じた酸素酸化物が水分と反応して酸となりレンズ表面に付着することで進行する。

【0004】 レンズアレイの焦点ばらつきの問題はプラスチックレンズで特に著しく、プラスチックレンズの場合はこれ以外にレンズ表面が平坦でないという問題もある。これはプラスチックレンズアレイは、プラスチックレンズを結束し切断しただけで、レンズ表面には切断時の傷がそのまま残っているからである。レンズアレイの表面が平坦でないことは、画像の乱れの原因となる。オゾンによる曇りの発生問題は、ガラスレンズで特に著しい。ガラスレンズの場合、酸素ミストが表面に付着すると、ガラス中のアルカリ成分が析出し、レンズの曇りとなる。レンズの曇りはオゾンに陥らず、大気汚染により生じた酸素酸化物や酸素酸化物でも、同様に進行する。このような曇りはアルコール等で拭き取ることが出来るが、複写機やプリンタファクシミリ等に組み込んだ

$$\Delta L \sim d \cdot (n-1) / n$$

だけ短縮する。そこで結像面がレンズから遠すぎる場合、レンズの結像位置に透明合成樹脂の被覆を設ければ、見かけ上結像面を近づけ、結像面に焦点位置を合わせることが出来る。逆に光線面が遠すぎる場合、レンズの光線面側に透明合成樹脂の被覆を設ければ、見かけ上

※画像ヘッドのレンズアレイ表面を被覆することは望ましい。ガラスレンズを用いた従来の画像ヘッドでは、600時間程度使用すると出力が約10%減少し、レンズの曇りの問題は大きな問題となる。

【0005】

【発明の課題】 この発明の課題は、オゾン等によるレンズアレイの曇りの発生や、切断時の傷によるレンズアレイ表面の平坦度の低下を防止し、同像装置の性能を向上させる事にある。

【0006】

【発明の構成】 この発明の同像装置は、同像素子と、該同像素子と光学的に結合したレンズアレイとを組み合わせたものにおいて、前記レンズアレイの少なくとも一部のレンズ表面を、透明合成樹脂で被覆したことを特徴とする。

【0007】

【発明の作用】 レンズの表面を透明合成樹脂で被覆すると、レンズはオゾンや酸素酸化物、酸素酸化物等から遮断され、レンズの曇りの発生を防止することができる。この結果、同像装置の交換寿命やメンテナンスの簡便を高めることができる。この効果は、ガラスレンズに対して特に著しい。被覆した透明合成樹脂はレンズ表面を平坦化しプラスチックレンズの場合に特に問題となる、表面の不平粗性による画像の乱れを除くことができる。

【0008】 透明合成樹脂での被覆は、特に限定するものではないが、次のように用いることもできる。プラスチックレンズの場合も、ガラスレンズの場合も、レンズアレイには焦点位置のばらつきがある。このようなばらつきは、レンズ内での屈折率分布のばらつきや、個々のレンズの長さのばらつき、あるいはレンズ間のピッチが異なる、またレンズが傾いており整列していない等の事で生じ、レンズ係に異なったばらつきとして現れる。なお焦点位置のばらつきは、プラスチックレンズでガラスレンズの場合よりも大きい。レンズアレイ全体が等しく標準からばらつくのであればともかく、焦点位置のばらつきは一つのレンズアレイの中でも個々のレンズ毎のばらつきとして現れる。このような個々のレンズ毎のばらつきの補正は、きわめて困難である。そこで被覆した透明合成樹脂の屈折率が周囲の空気等の屈折率と異なることを利用し、焦点位置のばらつきを補正する。

【0009】 透明合成樹脂の屈折率をn、周囲の媒質が空気で屈折率が1とすると、厚さdの透明合成樹脂の被覆を設けると、レンズと光線面と結像面との距離Lは、等価的に

(1)

光線面を近づけ、焦点位置を合わせることが出来る。結像面が近すぎる場合、レンズの光線面側に透明合成樹脂の被覆を設ける。これは、レンズアレイの空間周波数MTFで表した解像度が、レンズと光線面と結像面との距離が共に長すぎる場合や、共に短すぎる場合には余り低

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下せず、一方のみが長すぎるあるいは短すぎる場合には著しく低下することを利用したものである。同様に光源面が近すぎる場合には、レンズの結像面に透明合成樹脂の被覆を成ける。透明合成樹脂の被覆は、CCD素子等で焦点位置のばらつきをレンズ毎に測定してレンズ毎に行えるため、個別のレンズに応じた補正ができる。なおLEDプリンタヘッドのLEDアレイや、光電子アレイ、あるいは液晶シャッタアレイ等の歪み高さのばらつきをも補正する場合、これらのものをレンズアレイと一体化した状態で焦点位置のばらつきを測定し補正すれば、レンズアレイの焦点位置のばらつきとLEDアレイ等の歪み高さのばらつきを同時に補正できる。

【0010】

【実施例】図1〜図4に、レンズの焦点位置のばらつき補正の原理を示す。なお各図において、光源は図の左側に、結像面は図の右側に有り、光はレンズを左から右へ透過するものとする。また矢線は補正前の光の進路を示し、鎖線は透明合成樹脂で補正後の光の進路を示す。これらの表示は、全ての図で統一した。各図において、2はレンズで、セルフフォーカシングレンズアレイの個別のガラスレンズやプラスチックレンズとする、4は透明合成樹脂で、好ましいものは透明アクリル樹脂や透明シ

$\Delta L = d \cdot (n-1) / n$  となる。図3の場合、透明合成樹脂4で結像面8を見かけ上 $\Delta L$ だけ接近させ、(焦点位置を $\Delta L$ だけ近づけ)、短焦点の状態を補正する。図3の場合、結像面8の位置が近すぎるため長焦点の状態であり、光源面6側に透明合成樹脂4を被覆する。このようにすると見かけ上光源面6がレンズ2に近づき、結果的に長焦点の状態を補正できる。これはレンズの厚さには、光源面6や結像面8が共に近すぎる場合や共に遠すぎる場合には影響が少なく、一方のみが近すぎるあるいは遠すぎる場合には影響が大きいことを用いたものである。即ち長焦点の状態は結像面8が近すぎるのであり、光源面6を見かけ上近づけるのである。図4の場合、光源面6が近すぎるため短焦点の状態に有る。そこで結像面8側に透明合成樹脂4を被覆し、結像面8を見かけ上近づけ、短焦点の状態を補正する。これらのことから明かなように、長焦点の場合には光源面6側に、短焦点の場合には結像面8側に透明合成樹脂4を被覆すれば、焦点位置のばらつき

【0013】図5に、短焦点か長焦点かのばらつきを測定する方法を示す。10はセルフフォーカシングレンズアレイで、結像面8の位置にCCD素子や光電子増倍管等のイメージセンサを配置し、光源面6からの点光源の結像状態を観察する。なおLEDアレイの発光ダイオードは微小で、点光源と見做す。この状態で、イメージセンサを結像面8の左右に、あるいは左側や右側の一方に移動させ、画像ビームのビーム径の変化を観測する。短焦点の場合には、図6のように結像面8からA、Bへと

\*リコン樹脂で、この他にも透明エポキシ樹脂等も用い得、透明で耐酸等の酸への耐久性が高いものであれば良い。6は光源面で、ここではLEDプリンタヘッドのLEDアレイであり、8は結像面でここではプリンタの感光ドラムである。

【0011】図1に、光源面6が遠すぎるため、焦点位置が結像面8よりも遠方に有る(長焦点)状態を示す。図2に、結像面8の位置が近れ過ぎているため、焦点位置が結像面8よりも近方に有る(短焦点)の状態を示す。なお長焦点、短焦点の用語は、常に結像面8に関して用い、光源面6に関しては用いないものとする。図3は結像面8が近すぎるため長焦点となった状態を示す。図4は光源面6が近すぎるため短焦点となった状態を示す。これらのいずれの状態でも、長焦点で有れば光源面6側に、短焦点で有れば結像面8側に透明合成樹脂4を被覆し、焦点位置を補正する。

【0012】補正の原理を説明する。図1の場合、光源面6側に透明合成樹脂4を被覆すれば、レンズ2から見て光源面6は式(1)に従い、見かけ上接近する。見かけ上の接近距離を $\Delta L$ 、レンズ2と光源面6や結像面8との距離を $L$ 、透明合成樹脂4の厚さを $d$ 、その屈折率を $n$ 、周囲の媒体が空気で屈折率を1とすると、

(1)

イメージセンサの位置を固定させると、位置Cで画像ビームのビーム径は最小となり、再び増加する。一方長焦点の場合は位置Cで画像ビームのビーム径は最小となり、A、Bへと移動するにつれてビーム径は増加する。そこでビーム径が最小となる位置Cが、手前に有れば短焦点であり、遠方に有れば長焦点である。また結像面8からの位置Cのずれの距離で、焦点位置のずれの絶対値が判明する。イメージセンサを手前側に(A、Bの側に)のみ移動させる場合、結像面8と位置A、Bでの画像ビームのビーム径の変化パターンとC点でのビーム径の相対値から、短焦点か長焦点かの判別とずれの絶対値が判明する。

【0014】具体的には、レンズアレイ10とLEDアレイの基板とをセットし、感光ドラムの位置にイメージセンサを配置する。次いでイメージセンサを移動させ、個別のレンズ2毎に長焦点か短焦点かのずれの有無と、ずれの程度を測定する。この後にレンズアレイ10をLEDアレイの基板から取り離し、短焦点のレンズ2では結像面8側に、長焦点のレンズ2では光源面6側に、透明合成樹脂4を被覆する。被覆は、レンズ2毎に行い、被覆する厚さは図6〜図7の手法で測定した値に従って決定する。この後、LEDアレイを被覆した基板とレンズアレイ10をセットすれば、個別の発光ダイオードの高さのばらつきと、レンズ2毎の焦点位置のばらつきをも同時に補正できる。なおレンズアレイ10の焦点位置の補正は、レンズアレイ単体で行い、発光ダイオードの高さのばらつき補正は行わなくても良い。このようにし

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て塗布した透明合成樹脂4は、同時にレンズ2の表面をオゾンと空気中の酸素との反応で生じた硝酸ミスト等から保護する役割をも持つ。

【0015】焦点位置のばらつきはプラスチックレンズで大きく、ガラスレンズでは小さい。プラスチックレンズでは、焦点位置のばらつきの原因としてレンズ2の長さのばらつきが大きい。そこで図8に示すように、レンズアレイ10の表面の凹凸を測定し、透明合成樹脂4の被覆位置と厚さを定める。レンズ21のように結像面8の傾が凹の場合、短焦点であり、凹の傾度に応じて透明合成樹脂4の厚さを定め、結像面8側を被覆する。レンズ22のように、光面8側が凹の場合、長焦点であり光面8側に透明合成樹脂4を被覆する。レンズ23のように、結像面8側が凸の場合、長焦点であり光面8側に透明合成樹脂4を被覆する。レンズ24のように、光面8側が凸の場合、短焦点であり結像面8側に透明合成樹脂4を被覆する。レンズ25のように共に凹の場合は、透明合成樹脂4を両面に被覆しても良く、被覆しなくても良い。レンズ26のように共に凸の場合は、共に被覆しない、あるいは凸の傾度が大きい側に透明合成樹脂4を被覆する。なおレンズ2の表面の凹凸とは焦点か短焦点かの関係は、図6から明かである。

【0016】図9、図10に、プラスチックレンズの平坦化と焦点位置のばらつきの補正の、双方の処理をした変形例を示す。この場合、図9に示すように、レンズアレイ10の全面に薄い透明合成樹脂12を被覆し、表面を平坦化する。次いで図10に示すように、図8、図6の手法で短焦点か長焦点かの焦点位置のばらつきの有無と程度を決定し、それに応じて透明合成樹脂4による補正を行う。2つの透明合成樹脂12、4は一度に塗布しても良い。

【0017】プラスチックレンズの平坦化は、図11のように一對のヒータ14、14を用い、レンズの両端を加熱しながら加熱しても良い。加熱には、ヒータ14からの直接の熱伝導の他に放射加熱、マイクロ波加熱等の任意のものを用い得る。図12に平坦化後のレンズアレイ10を示す。平坦化したレンズアレイ10に、図6、図8の手法で、焦点位置のずれの補正を施せば、図10と同様に、平坦化処理と焦点位置のずれの補正の双方を施したレンズアレイが得られる。なお図11の平坦化で、圧力と加熱温度を増せば、レンズ3の表面が単に平坦化するだけでなく、図8に示した凹凸が解消され、焦点位置のばらつきの補正も行える。

【0018】図13にガラスレンズに施した、レンズ表面の保護と焦点位置のばらつきとの双方を行った変形例を示す。この場合、図6、図8の手法で、短焦点、長焦点の焦点位置のばらつきの有無と程度をレンズ3面に測

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定する。次いでこれに基づいて、透明合成樹脂4の被覆量を定め、両面に透明合成樹脂4を被覆する。焦点位置のばらつきがないレンズ27では透明合成樹脂4の厚さは最小とし、焦点位置のばらつきのあるレンズ28等では、短焦点の場合結像面8側の透明合成樹脂4を厚く、長焦点の場合光面8側の透明合成樹脂4を厚く塗布し、補正を行う。

【0019】

【効果の説明】この発明では、オゾン等によるレンズアレイの曇りの発生や、切断時の傷によるレンズアレイ表面の平坦度の低下を防止し、画像装置の性能を向上させる。

【図面の簡単な説明】

【図1】 実施例での光面とレンズとの距離が長すぎる場合の補正を示す図

【図2】 実施例での結像面とレンズとの距離が長すぎる場合の補正を示す図

【図3】 実施例での結像面とレンズとの距離が短すぎる場合の補正を示す図

【図4】 実施例での結像面とレンズとの距離が短すぎる場合の補正を示す図

【図5】 実施例でのレンズアレイの焦点位置ばらつきの補正を示す図

【図6】 実施例での焦点位置ばらつきの測定を示す図

【図7】 実施例での焦点位置ばらつきの測定を示す図

【図8】 変形例での焦点位置ばらつきの補正を示す図

【図9】 実施例での透明合成樹脂被覆によるレンズ表面の平坦化を示す図

【図10】 実施例でのレンズ表面の平坦化後の、焦点位置ばらつきの補正を示す図

【図11】 他の変形例でのレンズ表面の平坦化を示す図

【図12】 図11の変形例での平坦化後のレンズ表面を示す図

【図13】 図11の変形例でのレンズ表面の平坦化後の、焦点位置ばらつきの補正を示す図

【符号の説明】

2 レンズ

4 透明合成樹脂

6 光面

8 結像面

10 レンズアレイ

12 透明合成樹脂

14 ヒータ

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EPO SAS 4

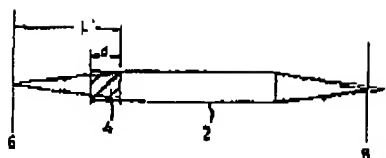
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P.006

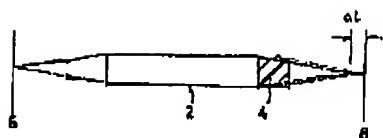
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【図1】



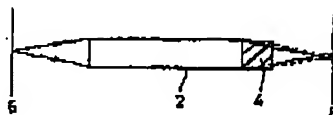
【図2】



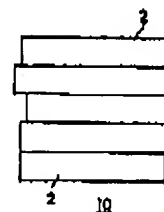
【図3】



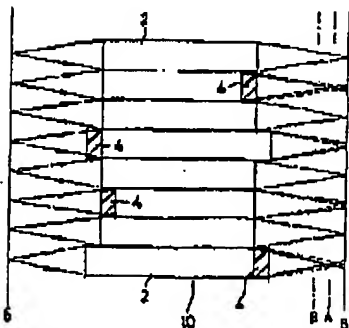
【図4】



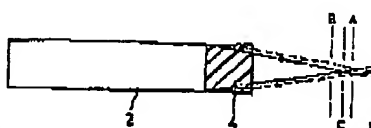
【図12】



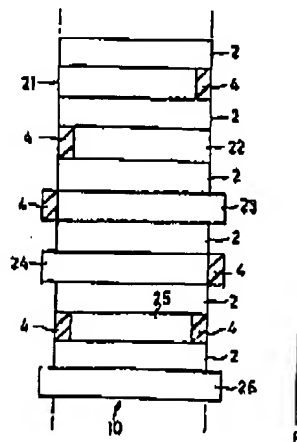
【図5】



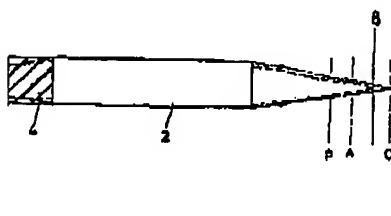
【図6】



【図8】



【図7】



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EPO SAS 4

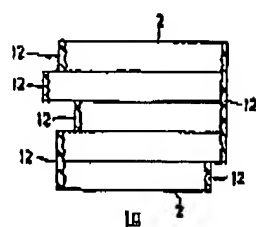
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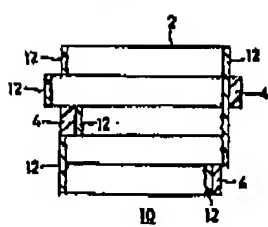
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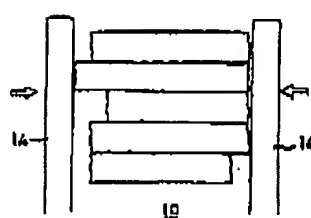
【図9】



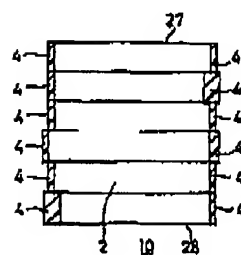
【図10】



【図11】



【図12】



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